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WHICH HAND IS THE EYE OF THE BLIND?*

From the Psychological Laboratory of the University of Missouri

By

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I

HISTORICAL TREATMENT

A. Historical Development of Blindscript

The first printing for the use of the blind was done in Spain, in 1580, by Francesco Lucas. He had observed a blind person reading slightly indented letters made by strongly impressed printing, and from this conceived the idea of carving the alphabet concavely into wooden tablets. While his system was legible to the blind, it was not suitable for general use. It is interesting to note here that the first systematic instruction of the deaf (given by Pedro Ponce de León, died 1584), as well as the first instruction of the blind, occurred in Spain, a country whose cultural contributions are often forgotten.

The first attempt to construct a script peculiarly fitted to the abilities of the blind was made in the eighteenth century by Vionville, a blind musician. His was the "binding-twine script," an alphabet composed of varying-sized knots in a string. It is a significant fact that Vionville introduced the use of symbols for letters instead of using the letters themselves made touchable. His invention was forgotten, however, and not directly known to those mentioned below.

Valentin Haüy is considered the "father of the blind," for he established, in the Rue Coquillière, in Paris, the first school for the blind. In 1783 he became acquainted with the Viennese lady, Maria Theresa Von Paradis, who, blind from early youth, had learned

to spell with letters cut out of pasteboard and to read words pricked upon cards with pins. The cards, bearing on them in relief the letters of the alphabet, were slid into a frame in the proper order to form words and sentences. At Haüy's school the art of embossing books was invented.

The embossed printing invented by Haüy, however, was not easily read by the blind. James Gall, of Edinburgh, improved it by making the letters larger, more open and angular, and by printing them in high relief. This was called the triangular system because of the prevalence of triangles within it.

The printed-card method of writing taught by Haüy was improved upon by J. W. Klein. The disadvantages of the Haüy method were these: the single letters, each embossed on a separate card, were so far separated in the composition that the blind were unable to progress beyond the stage of spelling out the words; the setting up of the letter cards required so much time that the majority of the blind refused to use them for making a touchable script, or print; and further, factory-made books were able to crowd the same material into half the space. Therefore, Klein made a kind of writing apparatus similar to that used for setting up type in a printing office. The lead type used had on one end surface the regular letter and on the other a combination of needle points which also formed the letter. Klein, forced by the technique of his procedure to replace the continuous letter lines of Haüy by dotted lines, very soon recognized the use of dots as an im-

portant invention for the benefit of the instruction of the blind in reading.

The first true script that could be written by the blind was the pointscript invented by Barbier (1767-1841). He was the first to recognize fully that, for the use of the blind, symbols made up of points should be substituted for the ordinary letters formed by continuous lines. Among all the script systems offered to the blind in his day, the square letters appeared to him to offer the simplest forms. It occurred to him, accordingly, to retain only the characteristic corner *points* of the square letters, to separate more widely these corner points, and to omit the non-essential middle points. In this new form the letters of the antique alphabet looked so different that it seemed possible to replace the conventional letters by arbitrary combinations of points better adapted to the use of the blind. In this manner Barbier arrived at an original pointscript which he called "night script" *(écriture nocturne)*. Although this system did not make good in the practice of teaching the blind, it was not entirely lost, for Braille profited from it in the invention of the system which has come to be regarded today as "the" blindscript.

Louis Braille (1809-1852), a blind primary teacher, was guided in devising his system by the practical needs of teaching the blind. At first he made the group of eight points the basis of his writing system, but soon discovered that all alphabetical signs and musical notes could be represented by various combinations of six possible points. This script did full justice to the requirements of the only available sense organ,

the touch sense, through the use of points instead of lines, and also through a grouping of points in a manner favorable to a unified perception. The true worth of this writing system, however, was at that time by no means recognized; at best it was considered as a kind of stenography which could be chosen by sufficiently clever blind people as an alternative for the usual writing method. Braille's discovery gave rise to the invention of several new kinds of script, all attempting to simplify the complicated letters, which have an intermediate position in practicability between the scripts of Klein and Braille.

In 1827 the Alston alphabet, composed of bold-faced, Roman capitals, was invented in England. The next system (1837) was the stenographic system devised by Lucas, of the Bristol Institution. The letters were formed of curves, strokes, and circles similar to those of Pitman shorthand. Neither of these reactionary systems appears to have gained much popularity.

The Moon system is composed of nine characters formed of arbitrary lines, arranged in different positions somewhat resembling Roman letters. Moon observed that when the blind have read to the end of the line at the right, they must trace back over the same line to reach the beginning of the next line at the left of the page. This gave him the strange idea of having the hand of the blind read on the return also. Accordingly, he modified the letters for the return reading, from right to left, into mirrorscript. This reversal produced a confusion between those letters which in unchanged direction were mirror-pictures of each

other. And yet, in spite of this difficulty, the Moon script was widely accepted in England, replacing the formerly used Alston and Lucas systems.

About the time when the Moon system was in wide use, the London physician, Dr. Armitage, had the misfortune of becoming almost entirely blind. This necessitated his learning one of the existing blindscript systems. He soon recognized the insufficiency of the systems then dominant in England, and turned his attention to the older kinds of blindscript, especially to the half-forgotten Braille. After constructing an improved form of the Braille writing apparatus, he succeeded in introducing this system into the blind schools of England. He also gave an impetus to the return of Braille script in Germany and Austria.

William B. Wait, New York, modified the Braille system into the New York Point system. In Braille, the six dots of which the words are composed are in three horizontal lines; in the New York system, they are in two. The latter system makes note, also, of the principle of recurrence, which is neglected by Braille. Instead of calling the simplest form, which is one point, *a*; the next simplest (two points), *b*; and so on, proceeding through the alphabet, the New York system calls the simplest form the letter of the alphabet which occurs most frequently in writing. That letter is *e*. The next symbol, two dots, is called *i*, since *i* is second to *e* in frequency. In this manner the symbols are successively named, in the order of their increasing complexity, for the letters arranged in the order of decreasing frequency.

Wait, while tring to "economize" in *writing effort* and in amount of *print paper,* seems to have completely overlooked the psychological fact that the reading "eye" of the blind has a *perceiving surface* which, when applied to the paper, has a greater vertical extent than horizontal extent.

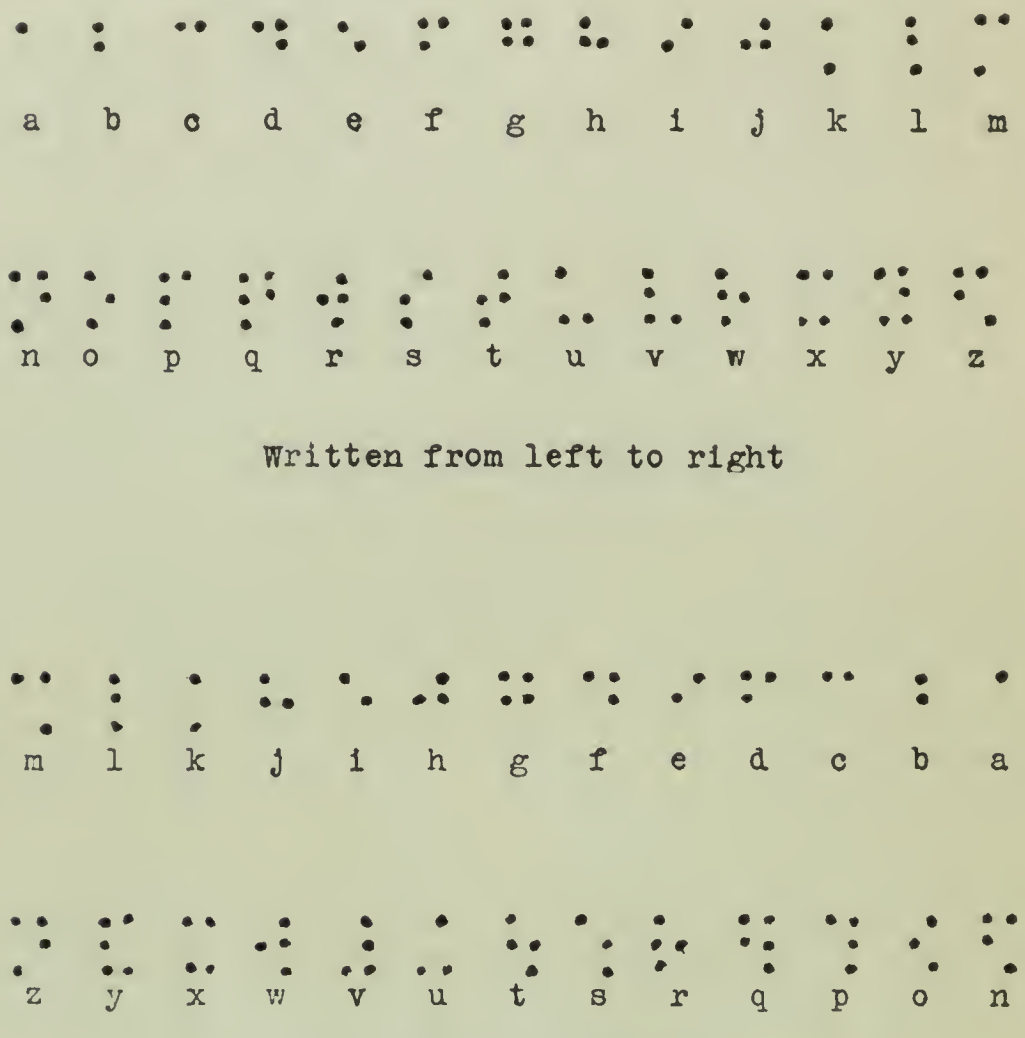

FIGURE 1
BRAILLE ALPHABET

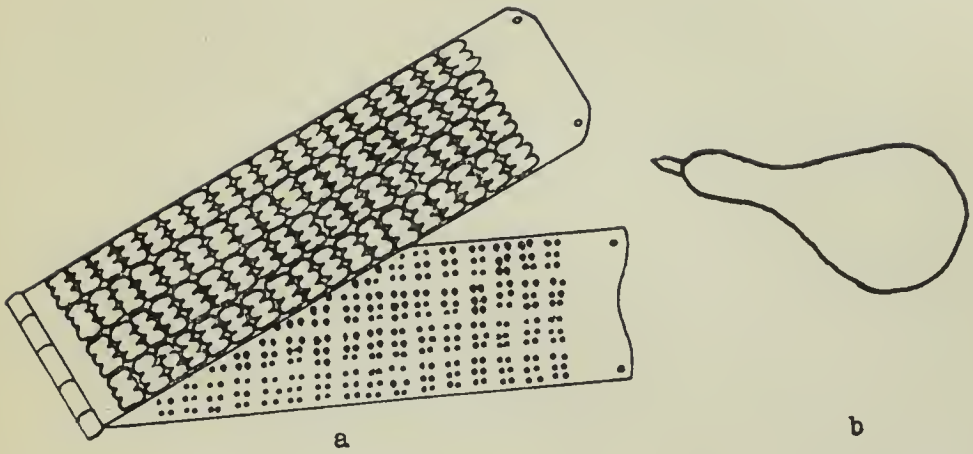

FIGURE 2

APPARATUS FOR WRITING BRAILLE

a — Frame for holding paper, showing holes for guiding stylus

b — Stylus used in punching symbols

Of all the systems which have been invented for instructing the blind, only these have survived: the Klein, the Braille, and the New York Point. Although the Klein system is still somewhat used, its use is constantly decreasing. The Braille system is almost exclusively used among the blind all over the world.

Typewriters for writing Braille are now available. They make it possible for seeing persons to write to the blind without having to learn the blind alphabet.

B. THEORIES CONCERNING READING OF BRAILLE SCRIPT

Since Braille is the most widely recognized system of blindscript, it is the only one which will be considered in this treatment. While Braille has been universally adopted by teachers of the blind, there is little

agreement as to how the reading of it should be taught, whether by the right hand, the left hand, or both hands. The advocates of each system advance theories as to the function of the two hands in reading to prove that their method is best.

Heller (5, p. 87), writing in 1904, states rather dogmatically that reading with both hands *must* be superior to reading with either alone, and assumes somewhat speculatively that in reading there is a division of labor between the two hands with a special function for each. According to Heller's theory, the left hand is used chiefly in keeping the line and for a slow, analyzing exploration, while the right hand furnishes the picture of the whole word or phrase. The truth underlying this statement seems to rest on the fact that *all normal reading* by a skilled reader becomes *"skimming,"* and that this in the blind is assumed by the right hand because its progress is never obstructed by the other hand (while reading from left to right).

Chlumetzky, 1918, also holds the opinion that the best manner of reading pointscript is with both hands.

"Only reading with both hands leads to a rapid and complete perception of what is read; however, of a separate and special mission which belongs to each of the two fingers I could discover nothing. It is true that my left index finger, when carried over whole phrases, is able to perceive these more rapidly and more easily than the right finger; however, the degree of this difference is very insignificant. Further, the right finger also is suitable for the recognition of single letters. But the distinction between the use of the two hands is never of any practical value with me."

He ends with the very significant statement:

"I value my reading fingers equally" (2, p. 133).

While he agrees with Heller that reading with two hands is superior to reading with one, he does not share the latter's opinion that each hand has a special function in reading.

The theories of these two men are based on personal experience, or observation made with no effort at control. There are three men, however, who have conducted investigations in the matter of reading blind-script and who draw a different conclusion from their investigations, that is, that the index finger of the left hand is the proper reading agent. Grasemann, one of the investigators, gave a text to a group of blind subjects, having them read it first with both hands, then with the left hand alone, and finally with the right hand alone. The results of the experiment, judged on the basis of the time of reading and the mistakes made, showed that almost one half of the subjects relied more on the left hand than on the right, the other half being divided between preference for the right hand and for both hands. On the average, 153 seconds were used in reading with both hands, 87 additional seconds in reading with the left hand, and 108 additional seconds in reading with the right hand. From these results Grasemann concludes:

> "We can assert that the right index finger can by no means be regarded as the proper reading finger, but rather the left."

On this ground he suggests that:

> "the teacher should, especially in the beginning of reading instruction, put the left forefinger on the script. But he must, if this finger fails, transfer to the right finger the role of the reading finger" (2, p. 134).

Similar tests made independently in 1918 by Bürklen and Hartmann confirm the results obtained by Grasemann. In their experiment, in which 66 blind readers were used as subjects, the results are (2, p. 134):

Either hand equally well	15 readers	23%
Better with left hand	30 readers	45%
Better with right hand	21 readers	32%

A very recent report, published by the Educational Publications Bureau of Research and Education of the American Foundation for the Blind, gives the impression of going back to the view that the right hand is superior in reading. It is, however, not an investigation nor an experiment but a report which pools the opinions of many teachers of the blind throughout the country, or rather mere statements of what they actually do. The editor of this pamphlet, Miss Maxfield, says:

> "Today there is hardly a teacher who would advocate the use of the left hand only for reading, except in the case of some child whose right hand is insensitive or missing, or who is congenitally left-handed. . . . . According to our data, children are allowed to read with either the right hand or both, although it is thought preferable to start them using both hands. When pupils have once gained considerable facility in reading, any natural inclination on the part of the pupil to read ahead on the next line with the left hand before finishing the preceding line with the right is not discouraged" (6, pp. 12 and 19).

The consensus of opinion among teachers of the blind is thus stated to favor the use of both hands; but it holds also that a right-handed child, when using one hand alone, *should be directed to use the right hand.* This misunderstanding of the total situation we challenge.

II

THE EXPERIMENT

A. Statement of the Problem

It appears that there are really three distinct opinions as to the best method of reading pointscript: with the right hand, with the left hand, and with both hands. Grasemann and Bürklen, who assert that if just one hand is used for reading the left hand is the better, make this statement on the basis of experimental data. The other opinions are unbacked by experiment.

But Bürklen's statement that the blind have better use of the left hand than of the right, (2, p. 134) seems surprising and contradictory to those who have a preconceived notion of the meaning of right-sidedness, when they consider that most people are right-sided. One possible explanation of his statement is that the blind have an acquired equipment, resulting from practice in reading and other use of the hands, which gives preference to the use of the left hand. Since all the subjects tested by these men had already had much experience in reading with two hands, from the left side of the page to the right (in which case the left hand is always the follower), it is possible to say that the left hand might have been better trained in making final decisions. Or, another possibility, the motions of the arm which use the flexor muscles might be more easily made than those which use the extensor muscles; in reading from left to right it is the left arm which makes use of the flexor muscles and the right arm which uses

the extensor muscles. Which muscles of the arm are used in the reading motion depends on both the direction of reading and the hand used: reading from left to right with the left hand and from right to left with the right hand involves use of the flexor muscles, and reading from right to left with the left hand and from left to right with the right hand involves use of the extensor muscles.

From these two possible explanations of the superiority of the left hand, as stated by Bürklen and others, arise two experimental problems: *first,* which hand is better for reading pointscript, and, *second,* is flexion superior to extension? A *third* related problem occurred to me later; that is, the question of the *sensorimotor* importance of right-sidedness, which might lead to an explanation of the superiority of the left hand in certain cases. On the answers to these three questions depends the decision, not a simple one a priori, as to which hand and which direction in reading should be used.

To determine the importance, in reading pointscript, of right-sidedness and of flexion–extension, I propose to have someone *entirely inexperienced* in reading pointscript in any manner learn to read with the left hand alone in the two directions, with the right hand alone in the two directions, and with both hands together in the two directions. It can then be found (1) which hand when used alone is better for reading, and (2) which direction is better for each hand.

B. Method Used

1) *Material*

The copy used in reading was grouped into six main parts, designated by the Roman numerals I, II, III, IV, V, and VI, and determined by the reading hand and the direction of reading. That is, I was read by the left hand from left to right; II by the left hand from right to left; III by the right hand from left to right; IV by the right hand from right to left; V by both hands from left to right; and VI by both hands from right to left.

Each of these six main parts was divided into twelve smaller parts, designated *a* to *l*. The material of all six of the *a*'s was the same, the letters of the alphabet being arranged in an order determined by chance. For each exercise the letters were drawn at random from a cup and were written on the copy in the order of their drawing. The *b*'s consisted of a group of common two-letter words, the same words appearing in all six groups but in different order. The *c*'s consisted of 25, and the *d*'s of 35, three-letter words, selected and arranged in the same manner. Therefore, while the words varied from class to class, all were of equal difficulty. The other groups, from *e* to *l*, consisted again of tasks of equal difficulty made up of different words of the same length arranged in accidental order. This material was written in Braille on sheets of paper and shellacked to preserve the form of the raised dots.

2) *Experimental Method*

The subject wore a pair of "cataract" glasses, through which nothing could be seen distinctly. The

copy to be read was placed before her. As a key, a strip of pasteboard on which the Braille symbols for the alphabet had been written very large was hung on the opposite but near wall, high enough that the subject could quickly see it by looking over the glasses. A stop-watch was used to find in seconds the time of each reading.

In each case, *a*, *b*, etc., the amount of work remained constant; that is, the task, the unit of material, was read through correctly. The time, which varied from reading to reading, was recorded. The key hanging before the subject, to which reference could be made at any time, was used as a check and prompter during the experiment to insure correct reading.

At the beginning of the experiment a great deal of time was naturally required to read even the smallest unit *a*, since the subject was entirely unfamiliar with reading pointscript. Therefore, at the first only *a* and *b* were read at one sitting. After the reading time had been considerably reduced, *c* was added as a further task. Later, *d* and *e* were added and then, in order, all the remaining units, so that at the end the amount read at each sitting was the entire material from *a* to *l*.

The reading was done six days a week, each day corresponding to one of the main parts, I to VI, but otherwise under approximately the same conditions. The work was done in a room which was quiet but next to a room in which there was some ordinary, weak noise; it was done at about the same time each day. The chief periodical variant, and the only significant one, was the reading hand and the direction of reading;

an unavoidable variant was, of course, the skill increasing from day to day, for whose computative elimination Meyer's method was used, as described below.

To avoid all possible misunderstanding, let us say distinctly that the Braille script when written to be read from right to left was in every detail mirrorscript of that to be read from left to right. That is, every letter, and not merely the succession of the letters, was itself reversed.

C. Computational Method of Determining Averages

The data, which were in units of a second, were plotted in a graph representing the amount of time taken by a trial and the corresponding number of preceding trials. The curve resulting is naturally ragged, although its general tendency is from greater to lesser amounts of time. Because of improvement due to the learning process which unavoidably takes place whenever a method requires that the same kind of task be repeated day after day for many weeks, an average cannot be computed by the usual simple method of adding these amounts of time and dividing by the number of summands. The data for each of the six different methods, therefore, have to be made comparable with each other by a particular computational method.

In order to compare the reading time under the various methods, it is necessary to find out first what would be the learning curve under normal conditions; that is, when by design but one method of reading is used and by accident no deviations occur. This nor-

mal curve ought to be a smooth curve running among the points of the experimental curve, which is ragged because of the varying methods used and because of accidental retardations. The data for the curve belonging to each special case of material (from *a* to *l*) are plotted separately.

The method used for computing the smooth curve is that of Meyer (8). What particular class of equation is used is irrelevant as long as it is an equation producing *a curve with an inflection point.* The true curve of the learning process is undoubtedly this kind of curve. Meyer uses a trigonometric formula because of the availability of trigonometric tables. No proof has thus far been furnished that any other curve with an inflection point is a more plausible one.

Although it is now generally agreed that the true curve of the learning process is one with an inflection point, it has not always been so agreed. L. L. Thurstone, for example, who as late as 1919 made the first systematic analysis of the form of the learning curve, indicates a totally different class of curve:

"This coefficient [previous experience] as well as the predicted limit is based on the assumption that the unmeasured part of the learning before and after the observations followed the hyperbolic law. This assumption seems to be fairly safe since other learning curves, the actual observations for which start with practically zero attainment and continue almost to the practice limit, usually follow the hyperbolic form" (13, p. 36).

Thurstone's assumption that "the unmeasured part of the learning before and after the observations followed the hyperbolic law" is probably never justified. It seems justified only when we measure the "attain-

ment" and, if this does not come up to a certain standard, call it "nothing at all." For example, in teaching a person the touch system of typewriting we would probably tell him at the beginning of the first lesson that he does not know how to typewrite at all. If, on the other hand, we make our subject perform a definite task, insisting that all errors be corrected before it is accomplished, and measure the time, learning never starts from a time inversely proportional to zero, that is, of infinite length, for that would mean that the task is one which is humanly impossible.

While Thurstone assumes clearly that the curve is usually hyperbolic, that is, not a curve with an inflection point, he does not say that it is certainly and always this hyperbolic form:

"While I have confined myself throughout to what I have called the hyperbolic form of the speed-amount curve it is quite essential to keep in mind that this form of curve is not universal and that consequently it is impossible to make sweeping generalizations except in so far as we explicitly limit ourselves to the relations which follow from the assumed hyperbolic form with which we started" (13, p. 41).

He also says:

"As has already been said, the speed-amount curve is usually hyperbolic but not always" (13, p. 23).

His article includes several curves, one of which has an inflection point so marked (13, p. 49, Fig. 13). From all this it follows that the proper variable to measure and to plot in learning experiments is not the amount of work done in a unit of time, but the time consumed in doing a unit of work.

That *the learning curve is universally one with an*

inflection point was first recognized in 1923 by Max F. Meyer. In his article on "The Equation of the Learning Function," he says:

"The inflection point is rationally demanded by the universal testimony [a kind of delusion, of course], in the beginning of learning a difficult performance, that 'I shall never learn that,' and at a later that 'I am surprised at the progress I am making.' It goes without saying that at a still later stage this progress becomes inconspicuous as it was at first" (8, p. 206).

In the same year in which Meyer's article on the learning equation appeared, Llewellyn T. Spencer wrote an article on the learning function (11). The curves he shows, giving the results of experiments in learning, are all curves with inflection points. Nevertheless, he does not recognize the appearance of the inflection point as a necessary and characteristic part of the general learning curve, but considers it as due to some exceptional disturbances in his experiments which he did not succeed in avoiding. This proves that in 1923 Meyer was the only psychologist who had the new conception of the learning curve.

The fact that the learning curve is now, only nine years after Thurstone's opposing analysis and five years after Meyer's affirmation, generally recognized as a curve with an inflection point is shown by the following confident statement of Elmer Culler, made in an address before the American Psychological Association:

"A wide variety of experimental evidence leads to the following propositions: (1) The learning process begins slowly, accelerating until the task is half complete, then again decelerating to zero as

mastery is attained, the whole curve being roughly symmetrical about its mid-point" (3 p. 143).

In using the learning function equation of Meyer, we represent the constant value $\frac{L-l}{\pi}$ by C (8, p. 208, Equation V). Then his equation V looks like this:

$$t = T + CT \text{ arc cot } (n + p).$$

By taking out the T, the equation becomes:

$$t = T\ (l + C\ [\text{arc cot } ((n + p))]).$$

By definition, t is "the duration of any test in which a finite task has been finished errorless"; n is "that number of such tests repeated at regular intervals, which have preceded any certain test." t and n are the only variables. C, the individual learning ability, is a constant, and was taken in all computations as 3.2. p is the "measure of the combined influence of all our instincts predetermined by heredity and of all that previous life experience of ours which is capable of extending its influence to any of the specific learning tests." T is "the limit which the duration of a test approaches without ever reaching it, no matter how large n becomes." p and T are constant for each curve, but differ from task to task, a to l (8, pp. 204-206).

By applying this equation of the learning function to our experimental data, smooth curves were found which represent the normal learning curve when the same task is repeated.

From the computations for the construction of each of these smooth curves which represent the time successively spent with the task material a, with the material b, etc., through to l, is then derived a corres-

ponding group of divisionary tables analogous to the four divisionary tables which are found in Meyer's publication (9, pp. 505-508). We have there in each case four divisionary tables because the object of that investigation was to compare the working efficiency under only four different conditions, that is, under sugar, tobacco, alcohol, or tea. We have here in each case six divisionary tables because we are comparing the working efficiency under six different conditions, as explained above.

Each divisionary table yields, of course, one average. The six averages of time spent for each task material are shown below in Table 2 under the column headings I, II, III, IV, V, and VI, and the nature of each task is indicated by marking the lines *a*, *b*, etc., through *l*.

D. Results

The actual curves look more interesting than the tables. But we shall waste no printer's ink and paper on publishing either the curves or the tables. We present only parts of Table 1 as a single example of how to proceed in this kind of computational work, if anyone else should want to use our method. Such work is naturally tedious. Table 1 is the last computed table for reading the material *b* (this happens to be the material in this sample) by all the six methods of using the hands or, stating it perhaps still more clearly, without any reference to any particular method. This table became the last because the data in the second and third columns, counting from the right side of the table, when they were plotted together, convinced the scrutinizing eye of a satisfactory agreement between the

TABLE 1

Sample Computation Made in Determining the Computed Value of t for Material b, and the Ratio of the Experimental to the Computed t

n	p	$n+p$	Arc cot	C arc cot	$l+C$ arc cot	T	$T(l+C$ arc cot)	Exper. t	Ratio
0	5.5	5.5	10.30	32.9	33.9	22	745.8	935	125
1		6.5	8.73	27.9	28.9		635.8	514	81
2		7.5	7.60	24.3	25.3		556.6	560	101
3		8.5	6.72	21.5	22.5		495.0	582	118
4		9.5	6.00	19.2	20.2		444.4	316	71
5		10.5	5.43	17.3	18.3		402.6	302	75
6		11.5	4.97	15.9	16.9		371.8	276	74
7		12.5	4.57	14.6	15.6		343.2	231	67
8		13.5	4.23	13.5	14.5		319.0	321	101
9		14.5	3.95	12.6	13.6		299.2	225	75
10		15.5	3.69	11.8	12.8		281.6	210	75
11		16.5	3.47	11.1	12.1		266.2	186	70
12		17.5	3.27	10.4	11.4		250.8	252	100
13		18.5	3.10	9.92	10.2		239.8	156	65
14		19.5	2.93	9.37	10.37		226.6	231	102
15		20.5	2.80	8.96	9.96		219.1	274	125
16		21.5	2.67	8.54	9.54		209.8	179	85
17		22.5	2.55	8.16	9.16		201.5	205	102
The n-values from 18 to 62 are omitted from this sample.									
63		68.5	.83	2.65	3.65		80.3	105	131
64		69.5	.82	2.62	3.62		79.6	90	113
65		70.5	.81	2.59	3.59		78.9	87	110
66		71.5	.80	2.56	3.56		78.3	80	102
67		72.5	.80	2.56	3.56		78.3	75	96
68		73.5	.79	2.52	3.52		77.4	140	181
69		74.5	.78	2.49	3.49		76.7	117	153
70		75.5	.76	2.43	3.43		75.4	90	119
71		76.5	.75	2.40	3.40		74.8	86	115
72		77.5	.74	2.36	3.36		73.9	73	99
73		78.5	.73	2.33	3.33		73.2	73	100
74		79.5	.72	2.30	3.30		72.6	84	116
75		80.5	.71	2.27	3.27		71.9	100	139
76		81.5	.70	2.24	3.24		71.2	73	103

computed and the experimental data. Five previous attempts, preceding this last, at computing (really for a greatly restricted selection of n-values) were discarded, that is, were used only in order to improve step by step the guessing of the parameters p, C, and T. The research worker interested in our method will find other examples in Meyer's two publications dealing with the learning curve.

The reader will trust without seeing all our tables and curves that we committed no serious errors of computation.

The data which really interest the reader are the averages shown in the six columns of Table 2. These are the time ratios obtained by dividing the time actually consumed in working by the theoretical, that is, computed, time which "ought" to have been consumed in the work. The experimental values are in our curves always found scattered considerably on both sides of the smooth curve, but in a manner which is typical. It will be remembered that every sixth value is for the same particular reading material combined with a particular manner of reading; that is, the ordinate values for abscissa value 0 and abscissa values 6, 12, 18, etc., are the experimental data of reading, say, material c with the left hand from left to right; the ordinate values for abscissa value 1 and abscissa values 7, 13, 19, 25, etc., are the experimental data for reading material c with the left hand from right to left; and so forth. The uniformity of the ragged curve consists in the regularity with which every sixth abscissa value rises above or falls below the other values. For instance, nearly every sixth value starting with 0 (6, 12, 18, etc.)

falls somewhat below the other surrounding values, whereas every sixth value starting with 2 (8, 14, 20, etc.) tends to fall above the surrounding values. This, of course, appears more clearly in the averages given in Tables 2 and 3.

Table 2 gives the averages of the ratios of the experimental to the computed values of *t* for the data in reading each kind of material, *a* through *l*.

TABLE 2

THE RESULTS OF APPLYING THE SIX METHODS TO TWELVE MATERIALS

	Left hand		Right hand		Both hands	
	I	II	III	IV	V	VI
	L to R	R to L	L to R	R to L	L to R	R to L
a	87±11	79±11	121±18	114± 7	93± 8	75± 9
b	93±10	85± 9	123±13	126±12	97±14	91±14
c	84± 7	78± 3	105± 7	125±13	102±10	106±11
d	83± 5	81± 4	121± 8	121± 8	96± 6	102±11
e	84± 7	82± 6	110± 7	130± 8	100± 4	98± 8
f	87± 4	80± 3	132±13	134± 9	95± 8	99± 9
g	89± 6	80±11	118±10	107±14	94± 5	101± 7
h	81± 5	77± 4	123±10	126± 9	98± 5	93± 5
i	84± 5	78± 6	124±11	122±11	103±10	98± 5
j	76± 3	77± 2	121± 6	120± 7	99± 6	92± 9
k	85± 1½	80± 5	111±14	131±10	112± 6	97± 2
l	82± 5	86± 5	123± 6	114± 4	105± 6	96± 7

Table 3 gives a summary of Table 2 which compares "the values of the reading ratios" of the hands used in reading.

TABLE 3

AVERAGES OF RATIOS OF EXPERIMENTAL TO COMPUTED TIME

Left hand		Right hand		Both hands	
L to R	R to L	L to R	R to L	L to R	R to L
85	80	119	123	98	95

The general conclusion which can be drawn from a glance at Table 3 is that *the shortest reading times* are those of the left hand; the longest, those of the right hand; and that the reading times when both hands were used were intermediate, that is, a little longer than those of the left hand and shorter than those of the right hand.

It will be noticed also that the variation between the two directions of reading by each hand is less than the variation between the two different hands: the times of reading by the left hand in the two directions differ by only 5, the times of reading by the right hand differ by only 4, and the times of reading by both hands, by only 3, while the average difference between the left and the right hands is 38. This would indicate that the hand used in reading is a more important factor than the direction of reading. But the direction is not totally indifferent.

The use of the boustrophedon in old Asia and Greece shows that, even in continuous reading, alternation of the reading direction is not a great hindrance. Who does not quickly recognize a person from his reverse profile photograph? When the boustrophedon was discontinued in favor of exclusive left-right by the Europeans and of exclusive right-left by the Arabs, ease of *writing* and not ease of *reading* was probably the determining factor. As writing becomes a skilled and fast occupation, especially when the letters within a word are written continuously into a unit in the manner which we call "cursive" writing, the reversal of the writing direction becomes very undesirable and

difficult. Only once in a while a left-handed child surprises her teacher by writing mirrorscript fluently. To the ordinary adult the writing of cursive mirrorscript is a task running too much counter to his acquired skill.

The well-known use of scriptural quotations and other written words for artistic designs (on Arabic book titles, coins, and walls like those of the Alhambra), with a complete distortion of the usual coherence of the letters, shows how easily *a little practice in reading,* taking "reading" in the sense of "recognition," can overcome apparent difficulties created by mere practical or artistic needs of the manner of writing.

E. General Conclusions

The purpose of this experiment (as stated above) is to determine: (1) which hand when used alone is better for reading; and (2) whether flexion or extension of the arms is more efficient. Table 2, which summarizes the results of the experiment, furnishes the basis for deciding these two questions.

First, which hand when used alone is better for reading? Column I of Table 2 gives the ratios for the time of reading by the left hand with the flexor muscles; column IV gives the corresponding ratios for the right hand. In each case, from *a* through *l*, as well as in the averages for all the cases, the ratios for the right hand are larger than those for the left hand. Those for the right hand are in every case above 100, while those for the left hand are below 100. The same thing is found to be true when we compare the columns II and III, which are the ratios for reading with the extensor

muscles by the two hands. The average ratio for the left hand in the two directions is 83; the average ratio for the right hand in the two directions is 121. From these facts we may definitely conclude that, when one hand alone is used in reading, *the left hand is superior.*

The second problem is to find whether the inward or the outward direction is the better one. To determine the better set of muscles, extensor or flexor, for the left hand we compare columns I and II. I gives the average ratios for the left hand from left to right (flexion), and II, the average ratios for the same hand from right to left (extension). We find that in every case in which the left hand is used, except one, the ratio for the direction left to right is larger than that for the direction right to left. The average difference, however, is only 5, an amount less than many of the variations from case to case. Furthermore, we find that for the right hand the direction right to left has an average ratio higher than the average ratio from left to right, by 4. From this we might conclude that the left hand reads more easily in the direction right to left, and the right hand more easily in the direction left to right; but the most correct statement would be that extension is only very slightly superior to flexion, not sufficiently to make the distinction very significant for educational practice.

To summarize: In reading blindscript, extension is very slightly superior to flexion and, the more significant conclusion which can be drawn, the left hand is decidedly superior to the right when used as a sense organ.

III

THEORETICAL CONSIDERATIONS

It still remains to be explained why a right-handed person should read pointscript more easily and efficiently with the left hand than with the right. A plausible hypothesis is the following: When the two hands are used together in an operation, and one hand is forced to serve as a *sensory* organ, the use of that same hand as an *effector organ* is interfered with. Such interference would be most disastrous for the primary effector organ, the right hand; it is less disastrous with the merely secondary effector organ, the left hand; therefore, the left hand is the one used in the sensory capacity. This is quite plausible when we consider that by definition of right-sidedness the right side's limbs are predominantly used, not for any and all possible biological functions but merely as a motor organ in producing an effect. Since the right hand is thus primarily occupied with motor activity, the left hand is the only one remaining to be chosen for service in the sensory capacity.

Someone may say that the hand which does the reading of the blindscript is, in reading, a motor rather than a sensory organ. But consider a blind person who is reading directions for making some object or for copying a design. He undoubtedly would execute the orders with his right hand, and so would have to read them with the left. Reading blindscript, while it involves moving the hand, is perceiving rather than ex-

ecuting. Our eyes, too, have to move in reading, but they are not for that reason to be considered primarily as motor organs.

The subject of dextrality has been a much discussed one. Rife, in his discussion of dextrality types (10), divides all persons into six classes on the basis of considering dextrality determined by the hand held nearest the business end of the tool. He calls the six classes *RRR*, *RRL*, *RLL* (for right-handed persons), *LLL*, *LLR*, and *LRR* (for left-handed persons). The type *RRR* is defined as one who uses the right hand preferably in both unimanual and bimanual tasks; the *RRL* individual as one who is right-handed for unimanual activities, bats right-handed, and sweeps left-handed; the *RLL* individual as one who is right-handed for the unimanual activities, but bats and sweeps left-handed. Rife determines these formulae by the principle:

"In designating bimanual dextrality it is generally agreed to call those individuals 'left-handed' who hold the left hand nearer the business end of the instrument" (10, p. 475).

The use of the billiard cue he treats as an exception to this general rule, however.

"The *RR* billiard player will hold his left hand nearer the distant end of the cue, for he is really performing a unimanual operation in which the left hand plays a passive role" (10, p. 479).

Rife in his treatment does not sufficiently analyze the activities on the basis of which he classes individuals. For instance, he speaks of "using the broom" as if there were but one way of using it. Anyone who has had experience in domestic life knows that the uses of the broom are almost without number. The most

common purpose, of course, is to sweep together light and loose stuff on the ground or floor. But there are different ways of sweeping a floor, depending on what is to be swept. A man who is sweeping a heavy snow-drift off the pavement does not sweep in the same manner as the man who is sweeping scraps in the printing office carefully in order to avoid raising dust. In the former case, he would use a forcefully pushing motion; in the latter, a gently pulling motion. He would, in consequence of the different manner of sweeping, hold the broom in different positions. In the case of sweeping the snow, the hardest and most skilled work would be done by the hand *farthest* from the "business end," and the (left) hand at the other end would serve as a mere sort of guide or bearing. In the latter case, of sweeping scraps in the printing office, the work is all of skill and none of force. It could be done almost as well with a long handled feather duster. No guide or bearing for the duster handle is needed for the work. Consequently the working hand would, in all probability, be nearer the business end, as Rife says. But these two methods of sweeping can by no means be treated as one simply because both are called "sweeping." The conception of "nearness to the business end of the tool" is without value. Confusion between and neglect in separating these two and all other classes of sweeping (think of sweeping the ceiling!) may be responsible for the apparent contradiction cited by Miss Downey, that:

"For many individuals the bimanual preference is the opposite of their unimanual preference. They throw, for example, right-handed,

but they . . . . use a broom or shovel left-handed, that is, with the left hand placed below the right" (4, p. 318).

Meyer calls attention to the fact, generally neglected by psychologists, that dextrality is not limited to the hands but extends over the whole body.

"We must substitute the term 'right-sidedness' for right-handedness, for the greater frequency of using the right side is not restricted to the Other-One's arm, but is equally obvious in the leg and in the head" (7, p. 203).

For example:

"When the child learns to skate, and nobody tells him whether to slide a certain curve on one foot or the other, he easily discovers himself, not only that he is right-sided rather than left-sided, but also that he is right-sided rather than merely right-handed" (7, p. 204).

It might be thought that the foot used in the activity was the preferred foot and indicated the dextrality of the subject; that is, that in skating, the foot upon which the skater glides is the preferred one, but:

"Balancing on one leg is easier on the left because the skillful part of the process of keeping from tumbling does not consist in supporting the weight of the body (the helper can do that!) but in readjusting the weight distribution quickly from moment to moment by the raised (right) leg, as the tight rope walker balances himself by shifting a heavy pole or loaded parasol held in his hands" (7, p. 340).

An analogy may be drawn between the sensory-left hand and the overestimation of size by the right side of the field of vision (12). Objects on the right side of a person fall on the left half of his retina. In the right-sided person the size of these objects seen on the right side and falling on the left side of the retina is overestimated. The overestimation of size by the left

half of the retina indicates a preferential use of that half of the sense organ. Such a preferential use is the natural consequence of the preferential use of the right hand in motor activity. The right hand, for example, in picking fruit, would be guided predominantly by the stimulation received on the left halves of the retinas. It is, then, comprehensible that, when one side of the body is used preferentially in motor activity, the side which is preferentially used in sensory activity should in many cases be the opposite rather than the same side of the body.

Another situation in which, of a pair of sense organs, the left one is the preferred is the use of the ears in the American telephone practice. Our telephones have the receiver hanging near the left ear in order to insure the use of the better hand for purposes such as taking notes. This has the result of forcing the left ear to be the listener. The European telephone practice, which permits holding the instrument with either hand, is more liberal (or should we say, "less efficient"?).

Many further illustrations may be given for this assumption of the sensory function of the left hand from everyday life. For example, when a right-sided man is fitting his key in the keyhole in the dark, he handles the key in his right hand while he feels for the keyhole with his left hand. Similarly, when he brushes his hair in the back, he brushes with the right hand and with the left feels whether the hair is smooth enough. There is almost no limit to the number of homely illustrations of the fact of the use of the left hand as a *sense organ*. All these illustrations also show,

again, how valueless is the concept of "nearness to the business end of the tool." Which end is the business end of a key or a comb? Nobody applies both hands to these tools and yet he uses both hands.

Another example of the use of the less skillful motor hand as a sensory organ is found in Miss Bowman's study, "Effect of Practice on Dextrality Types." In speaking of pegging, she says,

> "It is interesting to note that in most of the right-handed *S*s the left hand was much more skillful in 'feeding'" (1, p. 120).

An analysis of the phrase, "skillful in feeding," should make clear that it is the equivalent of "skillful as a sensory organ." In the operation of pegging, the work is so divided that while the right hand is doing the actual pegging on the board—motor activity—the left hand is holding the pegs and handing them to the right hand just where they are needed—sensory activity. The fact that in the "feeding" movement the left hand of the right-handed person is, according to Miss Bowman, more skillful than the right hand, indicates that the left is naturally more readily used for sensory activity, the right hand being needed for the motor activity of the real pegging, which is *controlled by the visual sense.*

From the above illustrations of the not infrequent preference of the left side in sensory activity—the retina and the ear, as well as the cutaneous sense of the left hand—it appears quite probable that when the blind use the hands together in an operation partly sensory and partly motor they would use the left hand preferably for the sensory purpose.

IV

EDUCATIONAL APPLICATIONS

According to current methods the blind child is taught to write pointscript with his right hand in the direction right-left and to read it with his right hand in the direction left-right. In the light of the results of the present experiment—the superiority of the left hand in reading and of extension over flexion—this pedagogy is not the most efficient.

The most efficient method of reading, as pointed out above, is with the left hand in the direction right-left. If reading were done in this direction, writing would have to be done in the direction left-right, as read pointscript is mirrorscript of written pointscript. It would, of course, be written by the right hand, since the right hand is the better one in such motor operations. It will be noted that writing with the right hand in the direction left-right makes use of the extensor muscles, whereas the present method of writing uses the less efficient flexor muscles.

Putting these principles into operation, however, would encounter several practical difficulties in our existing social environment. If the reading and writing methods both were changed in accord with the above suggestions, not only the pedagogical methods in teaching the reading and handwriting of pointscript would have to be changed but also all machines for writing the script would have to be remade. The second objection is perhaps the greater, for it involves

the economic factor. Typewriters and linotype machines are used in writing pointscript. The type of these two machines would have to be thrown away and new type made, since the letters for reading from right to left are mirrorscript of those for reading from left to right. Not only that, but the direction in which the carriage of the machines moves would have to be reversed, as the change is from writing in the direction right to left to that from left to right. At first glance this seems an almost insurmountable obstacle. But the cost of remaking the machinery now in use would not be too stupendous. There are not now a great number of typewriters or linotype machines for writing blindscript; and, furthermore, those in existence are not all alike. As mentioned in the first part of this paper, there are in use in the United States two systems of blindscript, the New York Point and the Braille. It would be a decided advantage to the blind if all machines of the two types were changed and made alike, and, if this change were made, it would be just as easy to make the changes suggested here at the same time.

There is still another advantage which would result from changing the direction of reading and writing pointscript: increase in facility of communication between blind and seeing persons. As pointscript typewriters are now built, the carriage moves from the left to the right, opposite in direction to the motion of ordinary typewriters used by seeing persons. This, of course, necessitates the existence of two entirely different kinds of typewriters. If, however, the blind wrote from the left to the right (as suggested here), the car-

riage of pointscript typewriters would move exactly as does the carriage of ordinary typewriters. Regular typewriters could be transformed into pointscript typewriters merely by substituting Braille symbols for the regular type. Or, better still, typewriters could be made with type which wrote the perforated Braille symbols and printed letters beneath the symbols at the same time. Such typewriters would write material with printed words on one side, and with perforated pointscript on the other side, legible at the same time to both the seeing and the blind. *The seeing would read the print from left to right; the blind would read the pointscript on the opposite side of the paper from right to left.*

Let us now consider the first difficulty, that of changing the pedagogical methods of the blind schools. Here we encounter the natural reluctance of people to give up old habits. Teachers who have been teaching the reading of pointscript from left to right would not like to change to teaching it from right to left. Also, the read symbols under this new system would be mirrorscript of the symbols as now read. The last objection, however, is really only an apparent one, as all blind people are familiar with the letters of the alphabet in both directions. They recognize words easily in either direction because they are used to writing them one way and reading them the other. A very little practice in reading in the opposite direction would be sufficient to accustom the blind to reading in the new way.

If the economic factor of remaking all machinery

now in existence for writing and printing blindscript were considered too great, an advantage but slightly less than that resulting from the complete change suggsted above could be secured by changing merely the hand of reading in elementary instruction, leaving the direction the same. Such a change in reading method would not prevent the blind person from using the other hand or both whenever he desired. In this case the symbols remain the same. The advantage of the greater efficiency of the left hand in reading would be immediately secured. This suggested change in the reading hand is in exact accordance with the suggestion made, about 1918, by Grasemann (see page 221).

If both changes, suggested above, in the method of teaching the blind child to read and write were carried out, observance would be made of the two principles pointed out in this experiment. If the change in reading only were made, the second principle mentioned would be observed. These principles are: (1) the slight superiority of extension to flexion; and (2) the conspicuous superiority of the left hand as a sensory organ and of the right hand as a motor organ.

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QUELLE MAIN EST L'OEIL DES AVEUGLES?

(Résumé)

Les expériences ici décrites prouvent que pour une personne droitière privée de sa vue et ainsi forcée tout d'un coup à apprendre l'usage des caractères faits pour les aveugles, la méthode la plus efficace, c'est celle *d'écrire avec la main droite* du bord gauche de la feuille *vers le bord droit,* et de *lire avec la main gauche* du bord droit de la feuille *vers le bord gauche.*

Les maîtres qui ont conçu les premiers l'idée d'instruire les aveugles, cependant, sans le savoir, ont établi la tradition tout à fait contraire de la règle citée en-haut; et les maîtres d'aujourd'hui suivent la tradition, ne doutant que rarement de son efficacité.

Celui à qui l'instruction des aveugles est une idée nouvelle, pense d'abord naturellement à leur enseigner à lire, seulement en second lieu à leur enseigner à écrire. Puisqu'il faut que les aveugles, en lisant, substituent un mouvement de main au mouvement de la prunelle, il semble assez naturel de leur donner quelque chose à lire avec un mouvement de la main droite vers la droite remplaçant le mouvement du point de fixation de l'extrémité gauche de la ligne vers la droite. Après cela on ne peut éviter d'enseigner aux élèves ou de tourner la page comme le dactylographe tourne les pages de son carnet et d'écrire sur le revers de la feuille avec le stylet perforateur de la gauche à la droite, mais avec les lignes suivant les unes les autres du bas vers le haut à la manière du compositeur dans l'imprimerie, ou de tourner la page comme l'on tourne les pages d'un livre et d'écrire sur le revers de la feuille avec le stylet perforateur de la droite à la gauche. Evidemment ceci exige le mouvement de la main (si c'est la main droite) avec les muscles fléchisseurs. Malheureusement on a adopté cette méthode-ci d'écrire.

Mais en attendant on a accumulé des données et les expériences ici données prouvent deux choses: (1) Une personne peut se servir plus efficacement de n'importe quelle main en motion quand la motion est déterminée par les *muscles extenseurs* du bras que quand elle est déterminée par les muscles fléchisseurs du bras. (2*a*) On peut lire plus efficacement avec les bouts des doigts de la *main gauche,* la lecture étant essentiellement une fonction *perceptive* de l'organisme; (2*b*) On peut écrire plus efficacement avec le stylet dans les doigts de la *main droite,* l'ecriture étant essentiellement une fonction *effective* de l'organisme. Par conséquent, pour obtenir la plus grande économie dans l'apprentissage et dans la vie qui viendra plus tard, on devrait enseigner dès le commencement aux enfants aveugles à écrire avec la main droite de la gauche à la droite, et à lire avec la main gauche de la droite à la gauche.

Le reversement des points-symboles (comme la typographie d'un livre vue dans un miroir) ne présente aucune difficulté nouvelle, puisqu'il faut que les aveugles, pour l'écriture et pour la lecture, se familiarisent avec chaque symbole en ses deux formes.

SMITH

WELCHE HAND IST DAS AUGE DER BLINDEN?

(Referat)

Die hier mitgeteilten Experimente beweisen dass für eine rechtshändige Person, die das Augenlicht verloren und daher plötzlich gezwungen ist die Blindenschrift zu erlernen, die zweckmässigste Methode ist, *mit der rechten Hand von links nach rechts zu schreiben,* und *mit der linken Hand von rechts nach links zu lesen.*

Die Lehrer jedoch die zuerst daran dachten die Blinden zu unterrichten wählten eine Methode, die dieser Regel ganz entgegengesetzt ist; und die heutigen Lehrer folgen diesem Beispiel ohne die Zweckmässigkeit dieser Methode in Frage zu stellen.

Der, dem der Blindenunterricht eine neue Idee ist, denkt natürlich zuerst daran ihnen das Lesen zu lehren, und erst nachträglich fällt es ihm ein ihnen auch das Schreiben beizubringen. Und da die Blinden beim Lesen durch eine Handbewegung die Bewegung des Augapfels ersetzen müssen, so scheint es ja ganz natürlich ihnen Material vorzulegen, dass sie mit einer Bewegung der rechten Hand nach rechts lesen können, indem sie auf diese Weise die Bewegung des Fixationspunktes vom linken Ende der Zeile nach rechts ersetzen. Dabei ist es aber unvermeidlich dem Schüler zu lehren, entweder das Blatt so umzuwenden wie die Stenographistin die Blätter ihres Notizblocks wendet, und mit dem Blindenstift auf der verkehrten Seite des Papiers von links nach rechts zu schreiben, wobei die Zeilen dann von unten nach oben laufen wie beim Schriftsetzer in der Druckerei; oder das Blatt zu wenden wie die Blätter eines Buches und mit dem Blindenstift auf der verkehrten Seite des Papiers von rechts nach links zu schreiben. Letzteres Verfahren bedingt natürlich, dass die Hand mit den Beugemuskeln bewegt wird wenn es die rechte ist. Unglücklicherweise führte man letztere Methode ein.

Doch kürzlich gesammelte Daten und die eben gemachten Experimente beweisen zweierlei: (1) dass jedwede Hand effektiver angewandt werden kann, wenn die Bewegung durch die *Streckmuskeln* des Armes bewirkt wird, als wenn sie durch die Beugemuskeln des Armes bestimmt wird. Und (2*a*), dass das Lesen, da es vornehmlich eine *wahrnehmende* Funktion des Organismus ist, erfolgreicher mit den Fingerspitzen der *linken Hand* ausgeführt wird; (2*b*) dass das Schreiben da es wesentlich eine *ausübende* Funktion des Organismus ist, wirksamer mit dem Stift in den Fingern der *rechten Hand* ausgeführt wird. Daher sollten, zum Zweck gröster Zeitersparnis beim Erlernen sowie im spätern Leben, blinde Kinder von vorn herein gelehrt werden mit der rechten Hand von links nach rechts zu schreiben, und mit der linken Hand von rechts nach links zu lesen.

Das Umkehren der Punktzeichen (gleich der Spiegelschrift) veranlasst keine Schwierigkeiten, da die Blinden ohnehin beim Schreiben wie beim Lesen jedes Zeichen in beiden Formen kennen müssen.

SMITH

КАКАЯ РУКА СЛУЖИТ ГЛАЗОМ ДЛЯ СЛЕПЫХ?

(Реферат).

Опыты данного исследования показывают, что для праворукого человека, лишившегося зрения и внезапно вынужденного научиться пользоваться письмом для слепых, наиболее действительным методом является письмо *правой рукой слева направо* и чтение *левой рукой справа налево.*

Первые педагоги, которые начали обучать слепых, установили традицию, противоположную выводам настоящего исследования, и педагоги в наше время все еще следуют этой традиции, не задумываясь о ее целесообразности.

Вновь начинающие обучать слепых естественно думают раньше научить их читать и лишь во вторую очередь научить их писать. А так как слепой при чтении должен движение глаз заменить движением руки, то кажется вполне естественным давать им материал, который надо читать движением правой руки вправо, заменяя движение фиксированной точки с левой стороны в правую сторону. Вслед за этим является необходимость научить слепых переворачивать страницы таким же порядком, как стенографистка переворачивает страницы своей тетради, и писать слева направо при расположении строк снизу вверх, так же как у наборщика в типографии, или переворачивать страницы, как мы переворачиваем страницы книги, и писать на левой стороне бумаги справа налево. Последнее требует сгибательного движения руки (в случае работы правой рукой). И этот метод письма, к сожалению, применялся.

Собранные настоящим исследованием данные показывают (1), что и та и другая рука могут быть лучше использованы, когда движение руки производится *разгибателями*, а не сгибателями и (2-а) что чтение, являясь преимущественно *перцептивной* функцией организма, может с успехом выполняться пальцами *левой руки*, в то время как (2-b) письмо, являясь *эффекторной* функцией, может быть выполнено более успешно пером пальцами *правой руки*. Поэтому слепые дети должны раньше писать правой рукой слева направо и читать левой рукой справа налево.

Буквы в обратном порядке (зеркальное письмо) не создают новых трудностей, так как слепой в письме и чтении должен быть знаком с каждой буквой в двух ее видах.

Смит (Smith).